MISCELLANEOUS PAPER NO. 4-844

XV5A AIRCRAFT FLIGHT TESTS LANDING STRIP EVALUATIONS

by

W. B. Fenwick

September 1966

Sponsored by

U. S. Army Aviation Materiel Laboratories
Ft. Eustis, Va.

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U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

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Foreword

The U. S. Army Engineer Waterways Experiment Station (WES) was requested by the U. S. Army Aviation Materiel Laboratories, Ft. Eustis, Va., in a letter dated 7 February 1966 to select and evaluate test sites for use in connection with flight tests of the XV5A aircraft. The results of this investigation were furnished the Aviation Materiel Laboratories in a Memorandum for Record, subject "Selection and Preparation of Sites for XV5A Aircraft Flight Tests at Edwards AFB, Calif.," dated 24 February 1966.

The field investigations were conducted by personnel of the Flexible Pavement Branch, Soils Division, WES, at and near Edwards AFB during the period 10 January-11 February 1966. Engineers actively engaged in the planning, testing, analysis, and report phases of the study were Messrs. W. J. Turnbull, Division Chief, A. A. Maxwell, R. G. Ahlvin, D. N. Brown, C. D. Burns, R. H. Grau, T. D. White, and W. B. Fenwick. Messrs. R. W. Patrick and R. T. Sullivan, technicians, assisted in procuring the data. This report was prepared by Mr. Fenwick.

Director of the WES during the investigation and preparation of this report was Col. John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany.

Contents

XV5A AIRCRAFT FLIGHT TESTS LANDING STRIP EVALUATIONS

Introduction

1. This report presents the results of a field investigation of sites for aircraft flight tests. The investigation was concerned with the capability of the aircraft to operate on or hover over unprepared or expediently surfaced landing strips. The report describes the test aircraft, purpose and scope of the investigation, and the test sites selected, which were located at or near Edwards AFB, California. It also discusses the XV5A aircraft operations conducted at several of the sites while the U. S. Army Engineer Waterways Experiment Station (WES) field party was still at Edwards AFB for this study.

Test Aircraft

2. The XV5A is a VTOL aircraft that has horizontal, 5-ft-diam, louvered fans in its fixed wings and a smaller fan in its nose for pitch control. It performs in the fan mode much like a helicopter and in the jet mode like a conventional jet fighter. The aircraft operates at a gross weight of about 10,500 lb and has a tricycle landing gear equipped with 20.00-4.4 main-gear tires inflated to 185 psi.

Purpose and Scope of Investigation

3. WES participated, during January and February 1966, in a test program conducted to establish the types of terrain suitable for operations of the XV5A aircraft. WES participation was limited to selection of sites at or in the vicinity of Edwards AFB that would represent an adequate range of conditions for establishment of terrain suitability. In the flight tests, the XV5A was to hover over various types of soil and surface conditions and to actually land where (a) soil erosion did not impair the pilot's vision, (b) soil erosion did not endanger the engines by ingestion of foreign matter, and (c) adequate soil bearing capacity existed.

Test Sites

4. Seven locations (excluding a water test and an air-taxi test) were selected to represent nine different test site conditions. Seven of the sites were unprepared areas and two were prepared areas. All soil classification at the sites was accomplished according to MIL-STD-619A, "Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations." At the time of the soil tests, the sites were very wet due to frequent rains, which resulted in unusually high moisture contents. During the flight tests performed at this time considerably less erosion of the finer soil particles occurred than would have occurred if the soil had been dry.

Unprepared sites

5. NASA construction site. This site is located about 1/2 mile northwest of the NASA Headquarters Building at Edwards AFB. (It was also used for tests on the prepared areas discussed later.) The NASA site had recently been used as a soil borrow area, and the top 12 to 18 in. of soil had been removed, including vegetation. The material classified as a silty, clayey sand (see plate 1), and in its moist, dense condition it exhibited far more than adequate soil bearing capacity. The XV5A landed successfully on this untreated site.

6. Drop zone site. This site is located 3 to 4 miles west of the General Electric test facility at Edwards AFB. It is a large area of silty sand (see plate 2) that has been plowed and pulverized to cushion landings of parachutists. Although the XV5A had not operated at this site at the time that the Memorandum for Record* on which this report is based was prepared, it was predicted that the high moisture contents mentioned earlier would more significantly reduce erosion here than at any other site. However, it was also predicted that this site would undergo the most severe soil erosion in spite of its moisture content. Both of these predictions were based on the pulverized condition of the material in

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* W. B. Fenwick, Memorandum for Record, subject "Site Selection and Preparation of Sites for XV5A Aircraft Flight Tests at Edwards AFB, Calif.," February 1966.

conjunction with its silty character. The inadequate soil bearing capacity at this site made landing impossible, so the objective was to hover as low as possible. Operation of the XV5A, subsequent to the memorandum, fulfilled the above predictions and the dust made the possibility of a landing highly unlikely.

7. Plowed, clodded field site. This site is located about 10 miles southwest of the main area at Edwards AFB. It is a barren, cultivated area that is normally used for agricultural purposes. The material classified as a sandy, silty clay (see plate 3). The site was very wet and had 2- to 4-in.-diameter earth clods covering the surface. Due to the low soil bearing capacity and the irregular surface, the XV5A did not land; however, it descended to a height of about 4 ft, with no erosion problems.

8. Sand site. The sand site is located about 8 miles southeast of the main base area at Edwards AFB and is adjacent to the south access road. It is a very uniform sand area (plate 4) with a minimum of vegetation. Although this site was not used, it was almost certain that the XV5A would be unable to land due to severe erosion. The uniform, loose condition of this sand (as with any uniform sand) makes it especially susceptible to continued erosion.

9. South base site. This site is located on the overrun area of the south base runway about 2 miles south of the main base. The soil characteristics are shown in two parts on plates 5 and 6 due to the very marked difference in composition. The top 1/2 in. of material at this site consists of a uniform, coarse-to-medium sand, and the material below this is a silty sand similar to that in the drop zone. The XV5A made a successful landing at this site with a minimum of erosion.

10. China Lake sod site. The sod site is located on the golf driving range at the China Lake Naval Air Facility about 80 miles north of Edwards AFB. The area was fully covered with bermuda grass and bluegrass sod. This sod was firmly rooted in a 1-in.-thick layer of fibrous, organic silt underlain by silty sand; the characteristics of the base material are shown in plate 7. The XV5A operated with no difficulty, and there was no damage to the site whatsoever.

11. Alfalfa field site. The alfalfa field is located about 12 miles

southwest of the main area at Edwards AFB. A mowed stubble, about 2 in. high, covered about 60 percent of the area. The soil classified as a lean clay (plate 8), and in its very moist condition, it resisted erosion during a landing by the XV5A. The soil bearing capacity was believed to be inadequate to support the XV5A, so the nose gear was held off the ground and the aircraft remained essentially in a hover. Each main gear, supporting an estimated 2000 lb, made a 1/2-in.-deep rut in the soil surface.

Prepared sites

12. Tests were conducted on two prepared areas at the NASA construction site. The preparations made at these two sites are described below.

13. T17 membrane-covered site. The T17 membrane is a 2-ply nylon material, 65 by 90 ft, covered with neoprene and weighing about 3 lb per sq yd. A road grader was used to cut V-ditches about 2 ft deep just inside the perimeter of the area to be covered by the membrane. The edges of the membrane were placed in the ditches and were anchored with six spikes along each edge of the membrane. The ditches were then backfilled and compacted by the road grader. The total time involved for the road grader was about 2 hr. The membrane was placed in about 45 min by 12 military personnel. The XV5A made a successful landing, with no damage to the site.

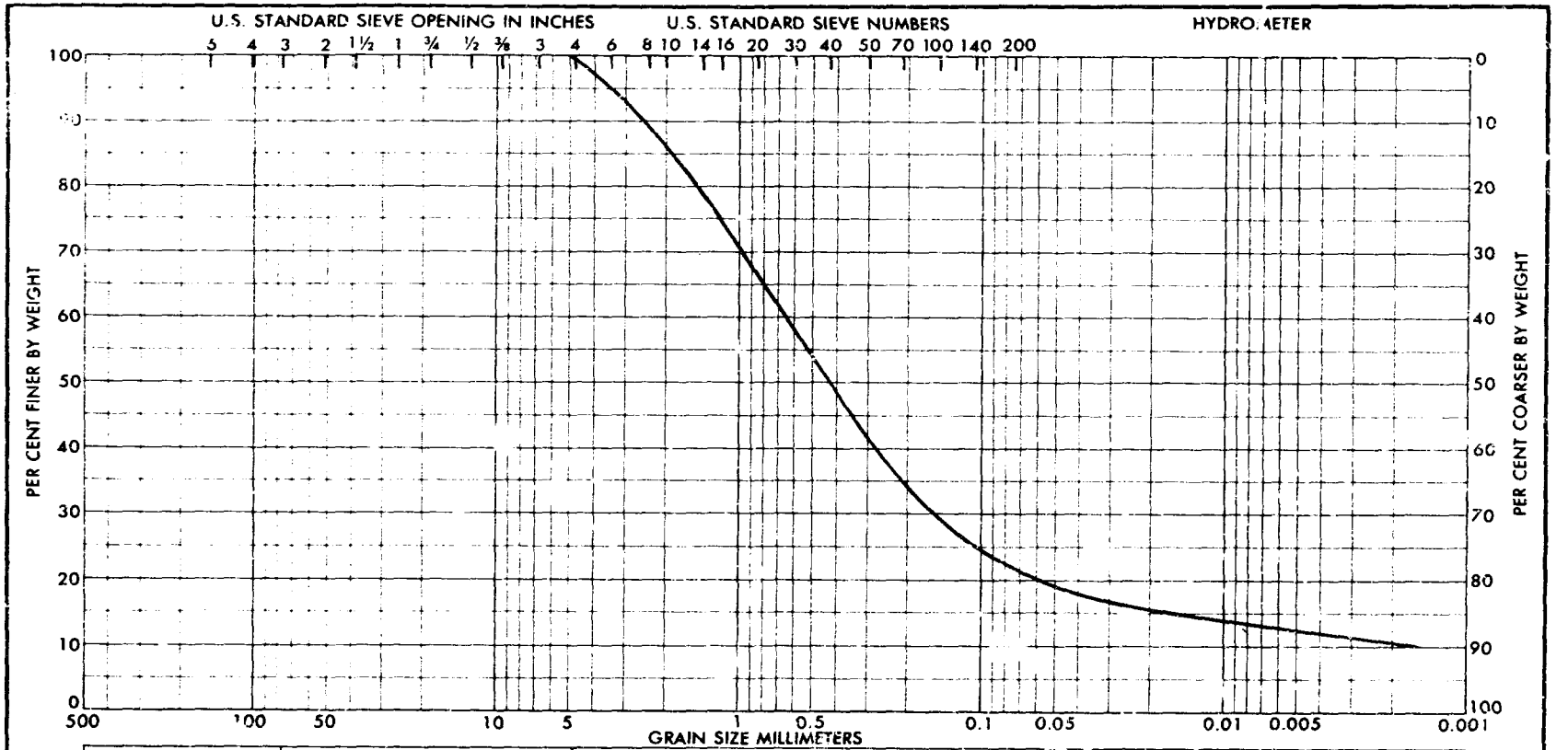
14. Asphalt-treated site. A cationic, emulsified asphalt was mixed in place in an attempt to dustproof a 100-ft-square area. About 4 gal per sq yd of the material was applied in increments with an asphalt distributor. The material was then pulvimixed and the mixture compacted with a pneumatic roller. The entire construction operation required about 7 hr. Operation of the XV5A below 20 ft at this site was impossible due to chunks of asphalt-cemented soil flying in the air. Three factors that contributed to the failure of the asphalt-treated section are listed below:

a. The wrong type of mixing equipment was used. A Wood's mixer should have been used instead of the pulvimixer. It would have permitted the asphalt to be sprayed directly into the mixer instead of on the ground for later mixing.

b. The temperature was too cold for placement of asphalt. The ambient temperature was in the 25 to 45 F range all day; and in spite of the asphalt being heated, this temperature range does not permit the proper curing of the material.

c. There was insufficient time to obtain soil samples and run laboratory tests to determine which type of asphalt stabilization would be most effective.

It is quite apparent from the failure of the asphalt-treated site plus the the excessive time and effort involved in its construction that this is not the answer to rapid preparation of VTOL landing sites. However, a number of surface-penetration and surface-sealing products are available and might warrant additional investigation.



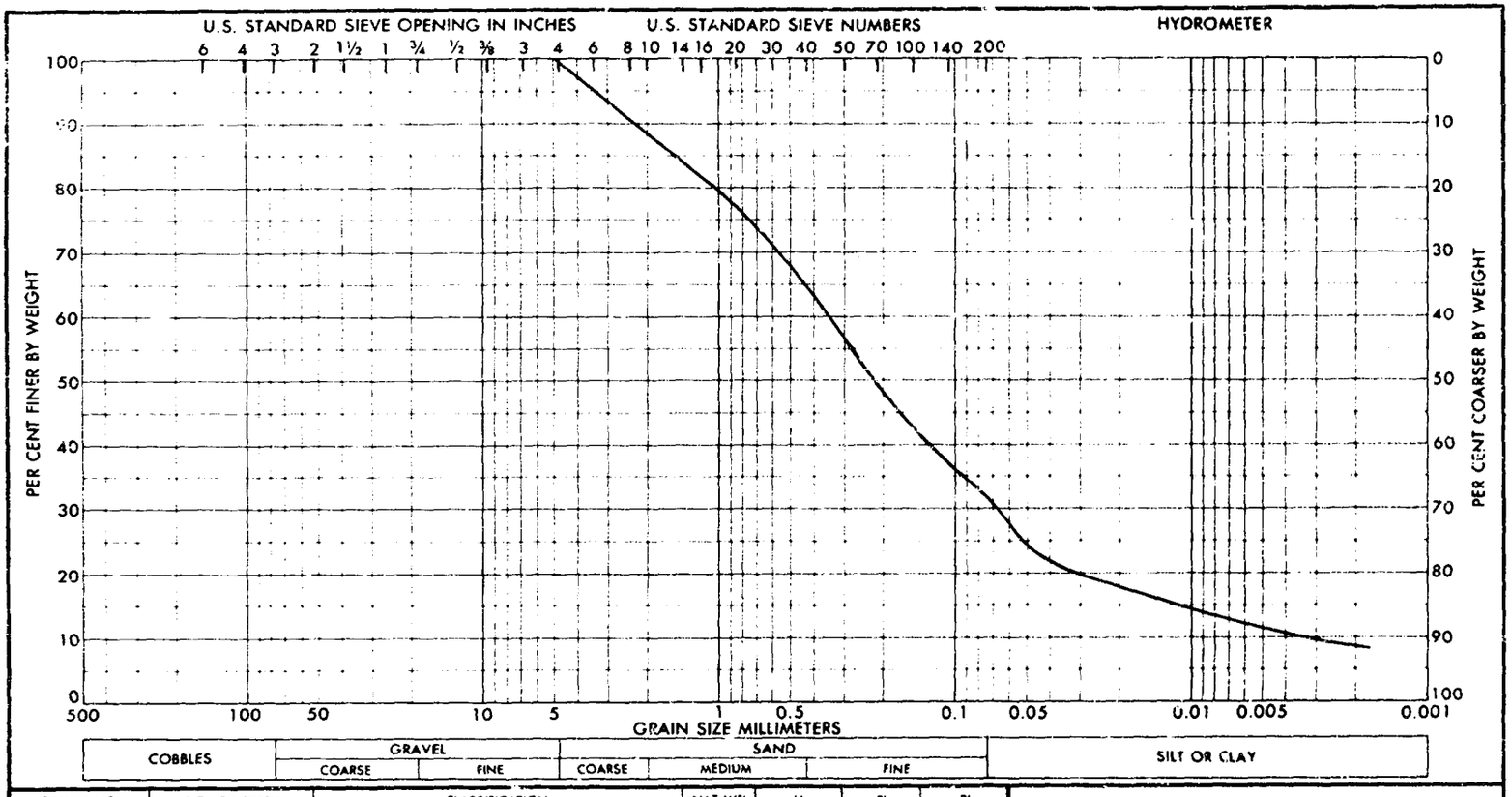
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1		Silty Clayey Sand (SC-SM)		19	13	6
		sp gr = 2.67 est.				

GRADATION CURVES

PROJECT XV5A Flight Test
NASA Construction Site
(Unsurfaced, T17 Membrane, Asphalt)
DATE 28 January 1966

PLATE 1

PLATE 2



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2		Silty Sand (SM)	9.1	16	15	1
		sp gr = 2.67 est.				

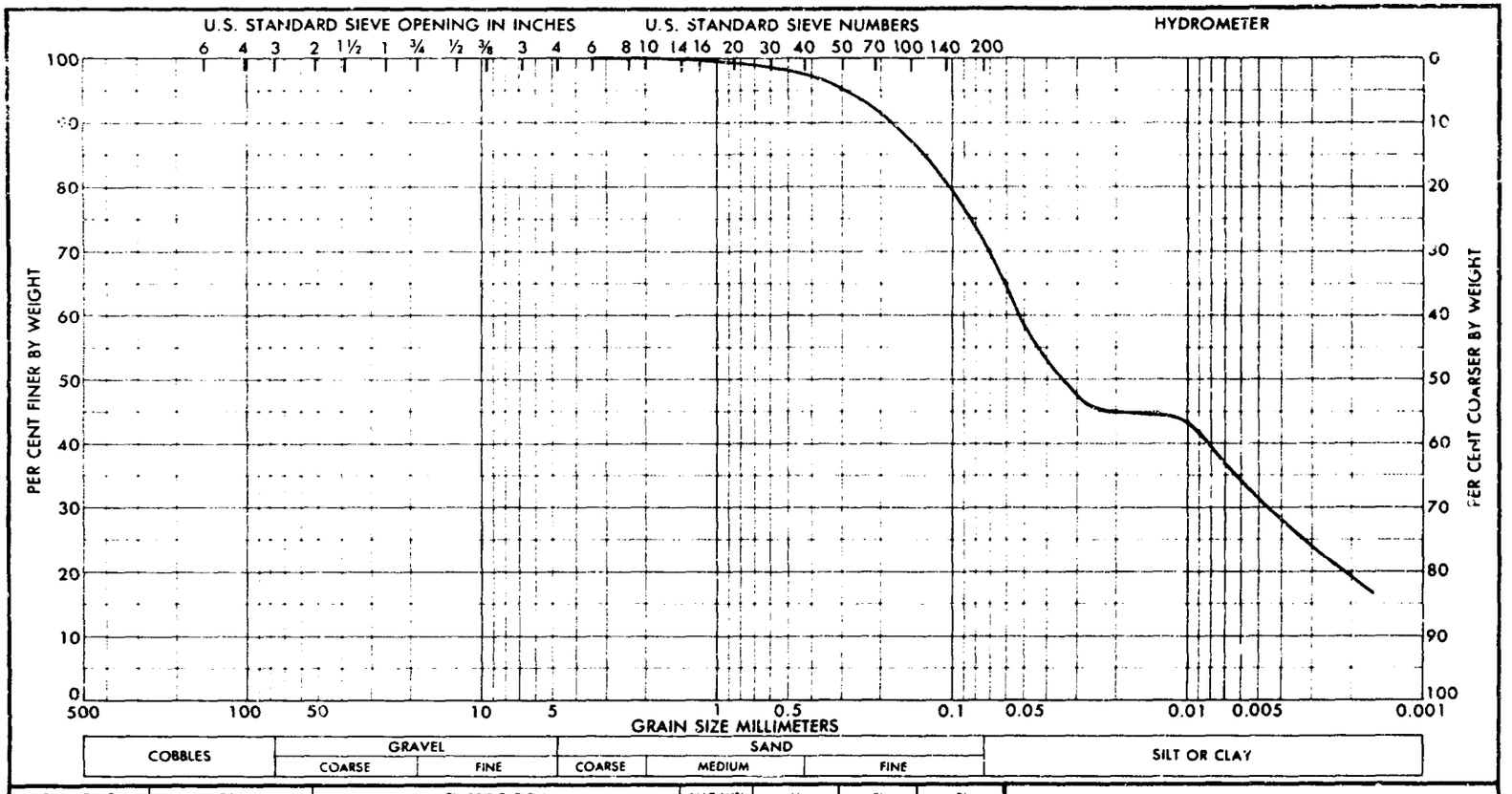
GRADATION CURVES

PROJECT: X75A Flight Test

AREA: Drop Zone

BORING NO.

DATE: 28 January 1966



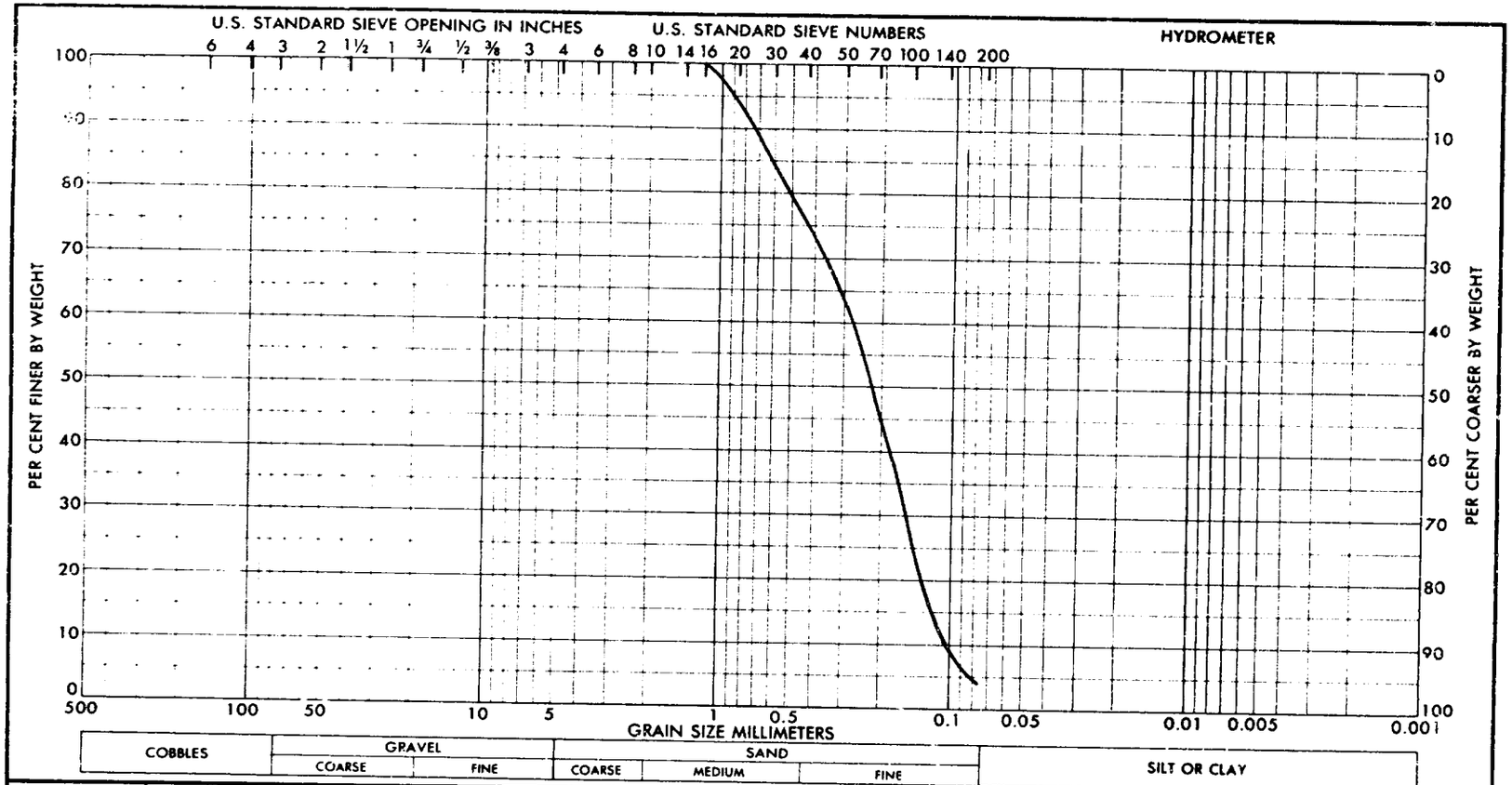
SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3		Sandy Silty Clay (CL)		22	14	8
		sp gr = 2.68 est.				

GRADATION CURVES

PROJECT	XV5A Flight Test
AREA	Plowed, clodded field
BORING NO.	
DATE	28 January 1966

PLATE 3

PLATE 4



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4		Sand (SP)				N. P.

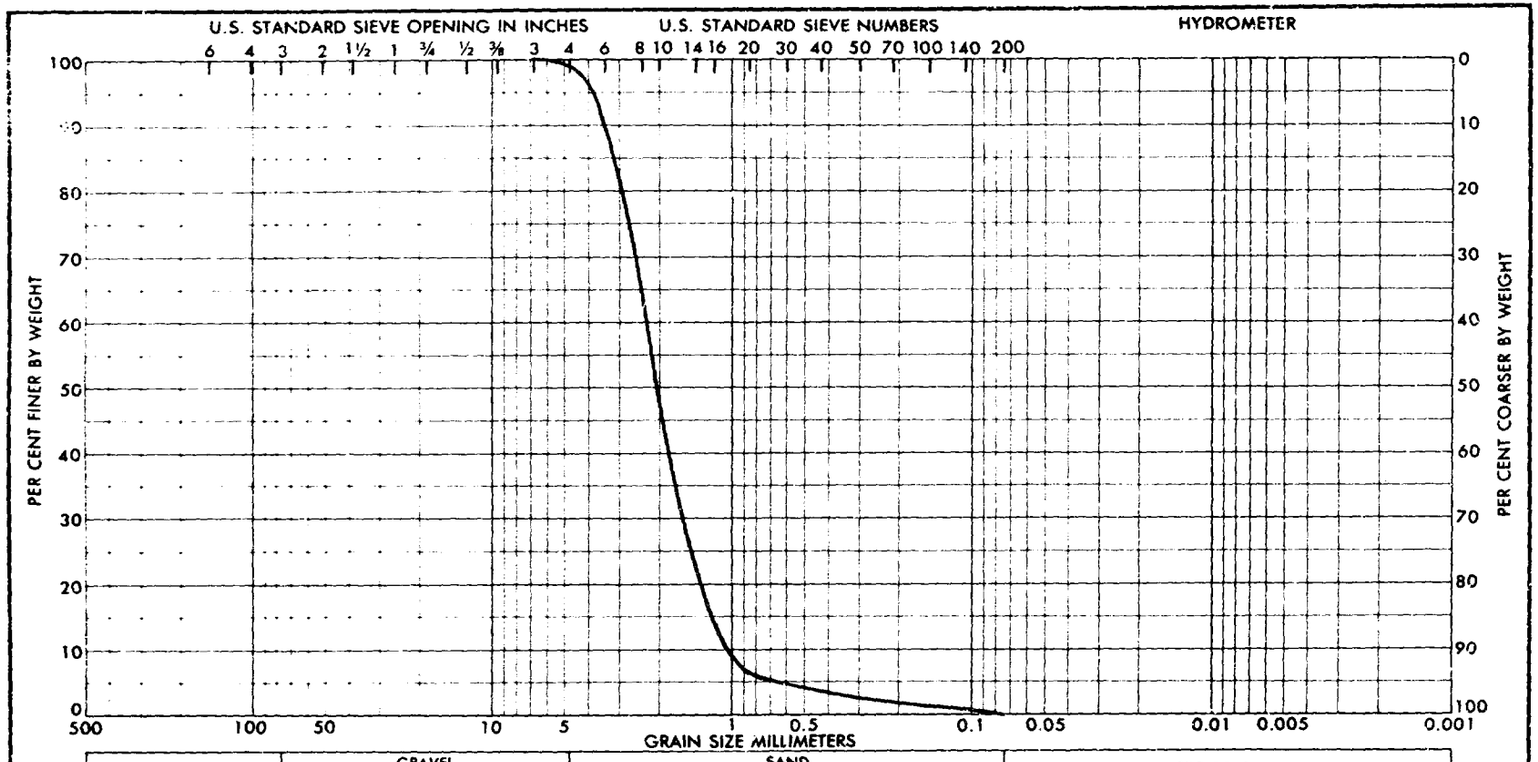
GRADATION CURVES

PROJECT: XV5A Flight Test

AREA: Sand

BORING NO.:

DATE: 26 January 1966



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5a		Sand (SP)				N. P.

GRADATION CURVES

PROJECT: XV5A Flight Test

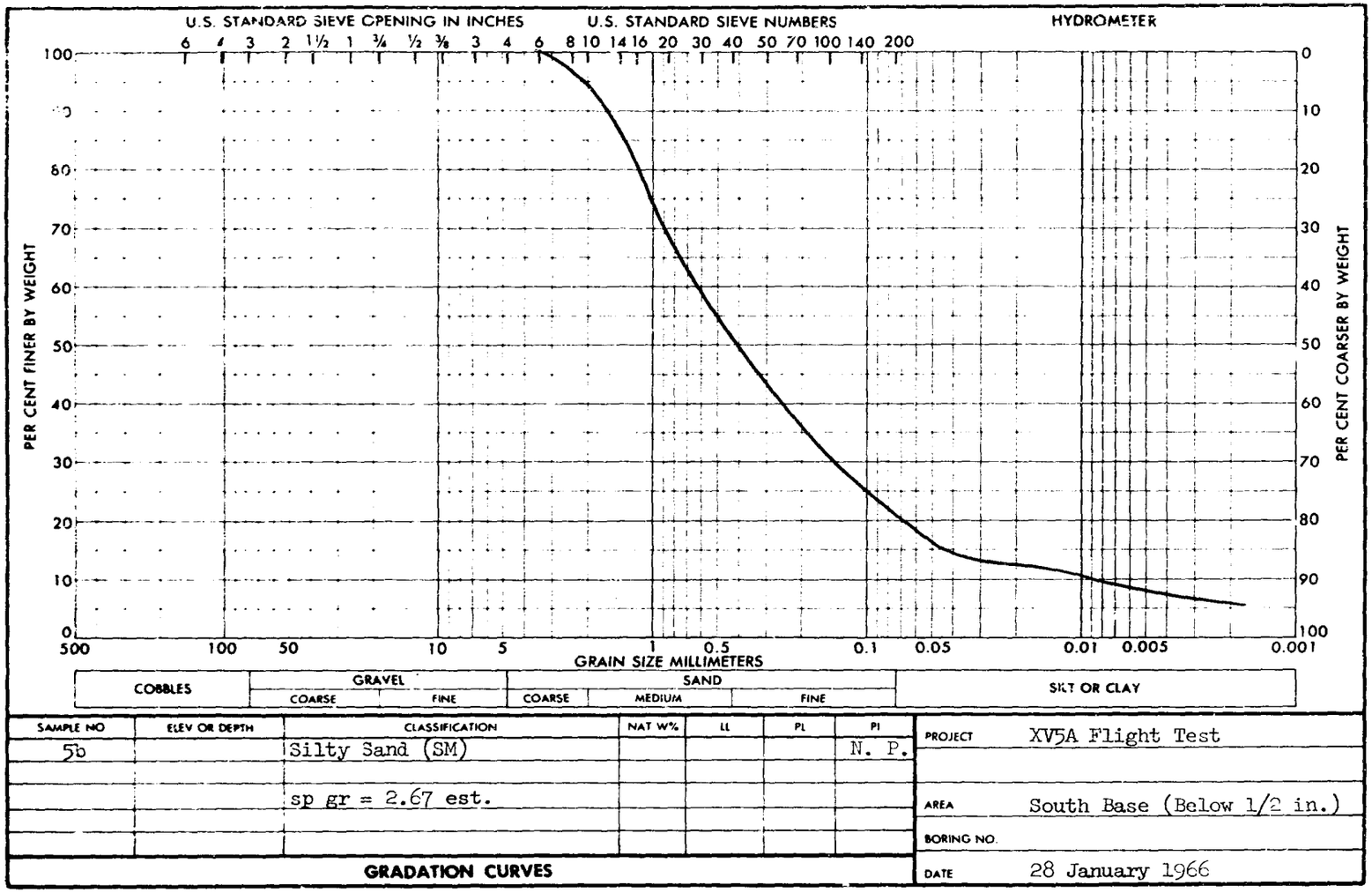
AREA: South Base (Top 1/2 in.)

BORING NO.:

DATE: 26 January 1966

PLATE 5

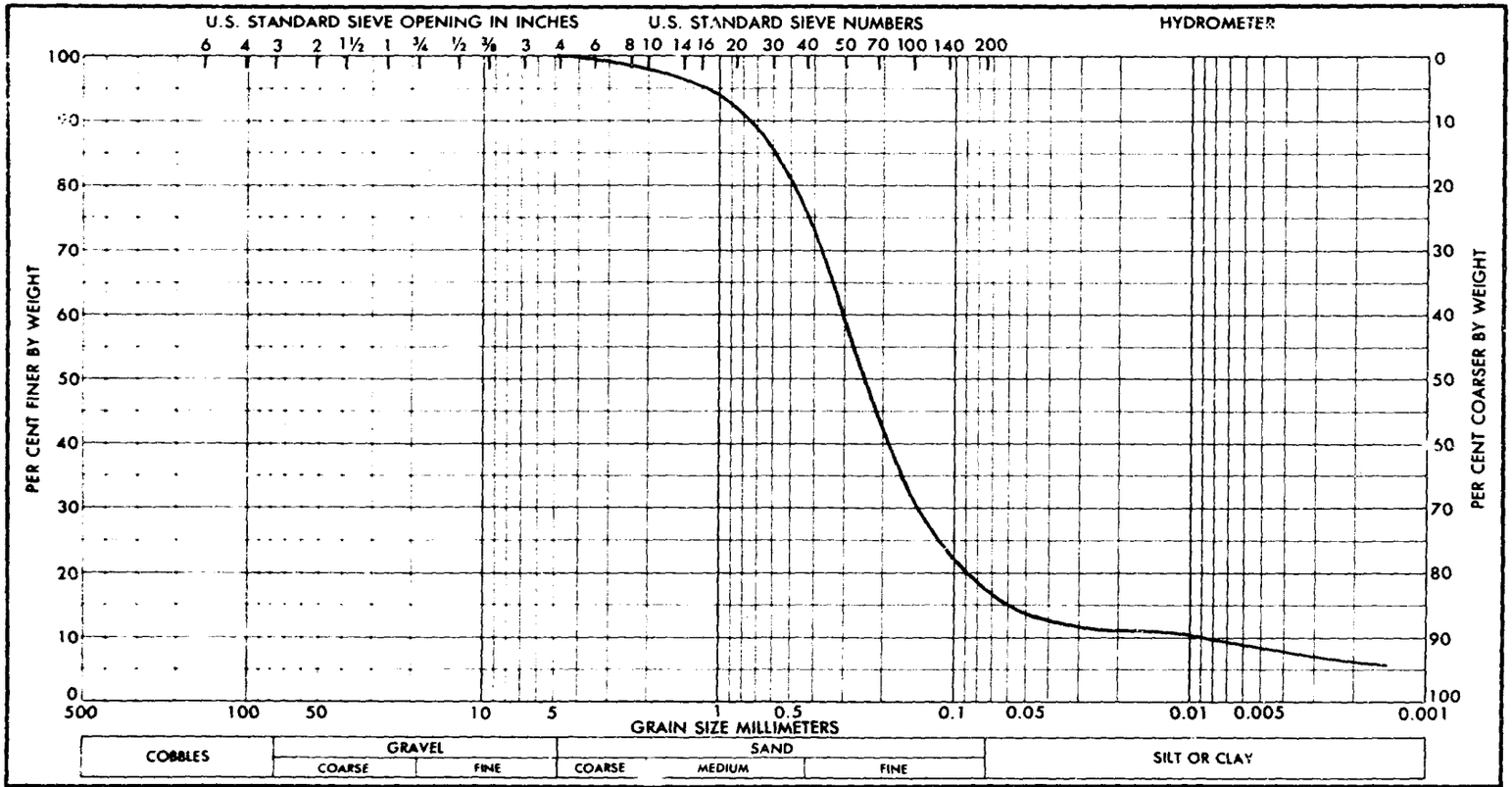
PLATE 6



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5b		Silty Sand (SM)				N. P.
		sp gr = 2.67 est.				

GRADATION CURVES

PROJECT	XV5A Flight Test
AREA	South Base (Below 1/2 in.)
BORING NO.	
DATE	28 January 1966



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
C		Silty Sand (SM)	7.9	18	20	N.P.
		tan				
		sp gr = 2.66 est.				

GRADATION CURVES

PROJECT: XV5A Flight Test

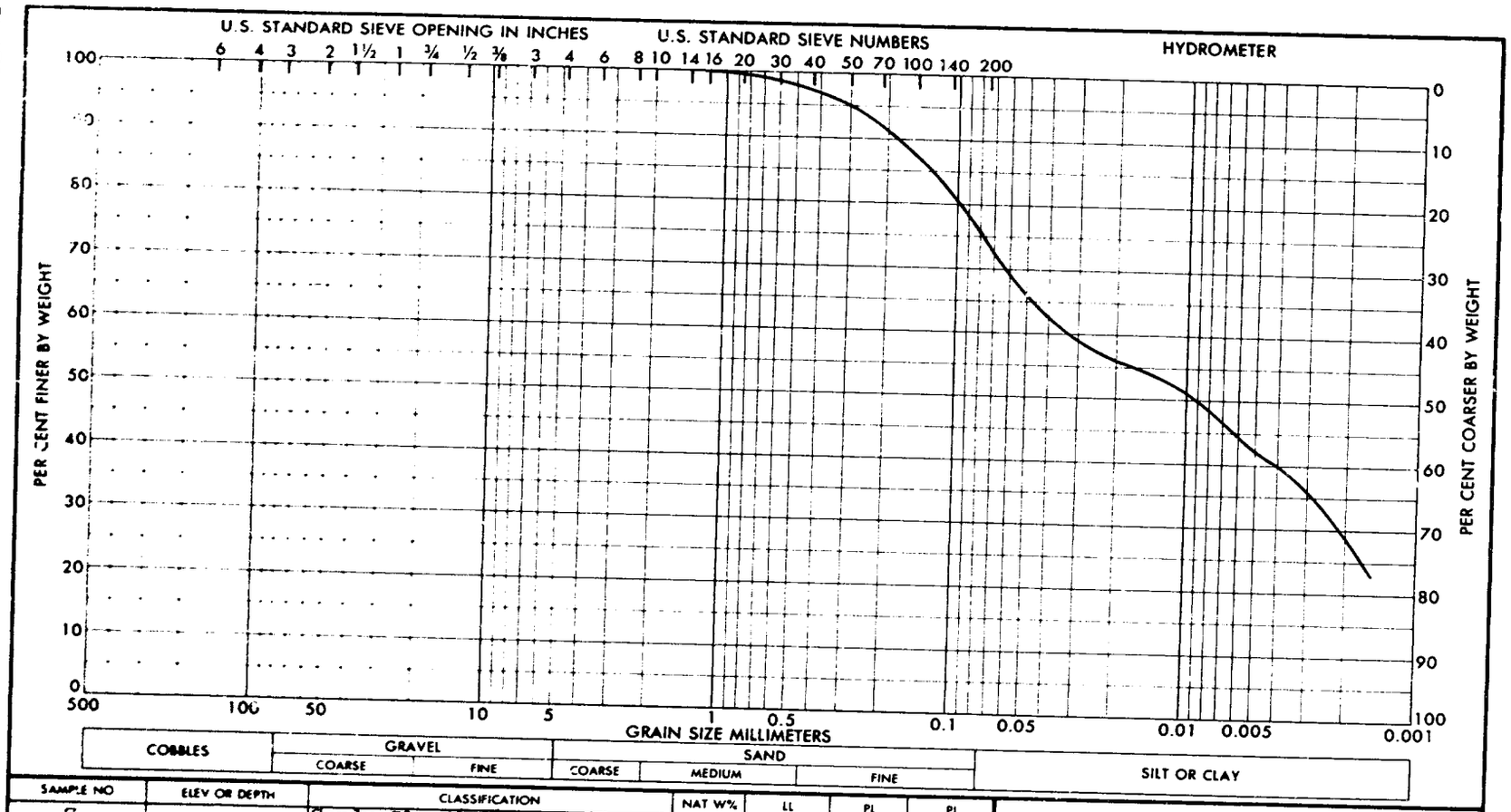
AREA: China Lake

BORING NO.:

DATE: 17 February 1966

PLATE 7

PLATE 8



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
7		Sandy Clay (CL)		34	19	15
		brown				
		sp gr = 2.69 est.				

GRADATION CURVES

PROJECT XV5A Flight Test

AREA Alfalfa Field

BORING NO

DATE 17 February 1966